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Research Article

Combining ability study using diallel mating design in Indian mustard

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Abstract The present investigation on Indian mustard was comprised of a half diallel set of 5 parents and their 10 crosses. Three cross combinations exhibited positive significant heterobeltiosis for seed yield/plant. On the basis of *per se* performance and estimates of heterosis, the cross IC-342777 × IC-339953 found to be most promising for seed yield/plant. GCA effects revealed that IC-335858 followed by IC-355856 having significant and positive GCA effects was found to be the best combiner for most of the yield contributing traits and on the basis of SCA, IC-342777 × IC-339953 and IC-342777 × IC-355856 was recorded best specific combination for most of the yield contributing traits. It may be concluded that IC-355856 is a good general combiner and IC-342777 × IC-355856 is a best specific combination for higher yield.

Key words: significant, yield, cross combinations, heterobeltiosis

Introduction

Indian mustard [*Brassica juncea* (L.) Czern & Coss.] commonly known as Indian mustard is globally used as vegetable, oilseed and condiments (Saleem *et al*., 2017, Kumar *et al*. 2019). Mustard belongs to family Brassicaceae and with Brassica genus. Indian mustard is a natural amphidiploids (2n=36) of *B. rapa* (2n=20) and *B. nigra* (2n=16) (Kaur *et al*., 2020). Indian mustard is the important oilseed crop after groundnut and contributes nearly 27% to edible oil pool of the country (Gideon *et al*., 2015). UP, Rajasthan, M.P., Punjab, Haryana, West Bengal, Assam and Bihar are the Major mustard growing states in India. Combining ability analysis is a useful breeding method and provides knowledge regarding the suitable parents for breeding program, magnitude and nature of gene action which control the inheritance of quantitative traits (Ceyhan *et al*., 2008). The knowledge of combining ability is useful to get information on selection of parents and nature of gene actions involved (Gideon *et al*., 2015). Combining ability analysis is a powerful method to test the value of parental lines to produce superior hybrids and for recombinants. Indian mustard being a self pollinated crop, the mating of diallel analysis for combing ability is very useful for screening of suitable lines for any breeding program. F_1 hybrids provide information about the genetic components and inform to the breeders to select a suitable breeding procedure for improvement of population and cultivar development (Channa *et al*., 2018). The present investigation was undertaken to study combining ability in IC lines of Indian mustard.

Methods and materials

Genetic material and field procedure

The research work on combining ability analysis of yield and yield components in Indian mustard crossed in an 5×5 diallel fashion was conducted at experimental farm, Mata Gujri College Fatehgarh Sahib, Punjab. Seeds for the experiment were obtained from the national Bureau of Plant Genetic Resources (NBPGR). All the 10 F_1s populations along with six parents were sown with in a randomized block design (RBD) with three replications during mid of September in three rows of five-meter length with plants and rows spacing of 20 and 40 cm, respectively. Data were recorded on selected F_1 plants and single plant selection was carried out in this generation. The data were recorded on days to first flowering, number of primary branches, number of secondary branches, plant height (cm), number of siliquae per plant, siliquae length (cm), number of seeds /siliqua, days to maturity, biological yield / plant (g), harvest index (%), Test weight (g), seed yield /plant (g).

Result and discussion

The success of any breeding programme largely depends upon the choice of parents and breeding procedure adopted. Combining ability is an efficient tool to discriminate good as well as poor combiners and for choosing suitable parental lines in hybridization programme. It also provides information of specific promising combinations to exploit heterosis.

The analysis of variance of combining ability for portioning the total genetic variance into general combining ability (gca representing additive type of gene action) and specific combining ability (sca, measure of non- additive gene action) we carried out by the procedure suggested by Griffing (1956) Method 2 and Model-I. The analysis of variance for combining ability for all the characters under study. Variance due to gca as well as sca was significant for all the characters studied. Magnitude of gca variance component was higher than sca for all the characters. The estimates of general combining ability (GCA) effects parents and specific combing ability (SCA) effects of the crosses for all the thirteen traits been presented in Table 1 and 2.

For days to first flowering out of five parents one parent IC335858 (2.876) exhibited significant positive gca effects for this trait and out of two parents the parent IC342777 (-3.648) exhibits significant negative effects for this trait. For days to first flowering out of ten crosses the cross combination IC335858 × IC342777 (5.349) exhibits significant positive sca effects for this trait. Similar finding were also discussed by Singh *et al.* (2019b)

For days to 50% flowering, one parent IC355856 (2.000) exhibits significant positive and the parent IC338586 (-3.000) exhibit significant negative gca effects. For days to 50% flowering, One cross IC 335858 × IC 355856 (1.143) had recorded significant positive sca effects while out of ten crosses, one cross IC338586 × IC342777 (4.524) exhibited significant negative sca effects for this trait.

One parent IC335858 (-3.238) exhibit significant negative gca effect for number of secondary branches. Out of ten two combinations cross IC 338586 × IC355856 exhibits significant positive effects while one of the cross IC338586 × IC339953 (-9.130) exhibits significant negative sca effects.

The estimates of combining ability effects for plant height revealed that one parent IC 342777 (6.722) expressed positive significant gca effects and parent IC355856 (-9.754) was exhibited significant negative gca effects and for this trait. For positive significant sca effects, Out of ten crosses, one cross IC 335858 × IC 355856 (20.946) had recorded significant positive sca effects while none of the cross exhibited significant negative sca effects for this trait. Our results are in line with Kaur *et al*. (2019)

One parent IC355856 (63.588) exhibit significant positive gca effects while one parent IC 335858 (-50.924) exhibits significant negative gca effect for number of siliquae per plant. One cross IC342777 × IC355856 (-90.262) exhibited significant negative sca effects while none of the cross exhibited significant positive sca effects for number of siliquae per plant.

The estimates of combining ability effects for number of siliqua length/plant revealed that none of the parent exhibited significant positive or negative gca effects for this trait. For positive significant sca effects, cross IC338586 × IC355856 (-10.965) had recorded significant negative sca effects for this trait.

One of the parent IC335858 (-0.662) exhibited significant negative GCA effect for number of seeds/siliqua. One of the cross IC335858 × IC338586 (2.051) shows a positive and the cross IC338586 × IC339953 (-1.640) exhibits negative sca effects for number of seeds/siliqua. Similar results were also observed by Singh *et al.* (2019b)

One parent IC355856 (5.448) exhibit significant positive and one of the parent IC 342777 (5.314) exhibit negative gca effect for days to maturity. For days to maturity, one cross IC338586 × IC342777 (14.762) had recorded significant positive sca effects while out of two crosses the cross IC338586 × IC355856 (-12.667) exhibited significant negative effects for this trait.

The estimates of combining ability effects for biological yield/plant revealed that one parent IC335858 (14.040) expressed the positive significant gca effects and the parent IC 355856 (21.912) showed significant negative sca effects for this trait. For positive significant sca effects, Out of three crosses, one cross IC342777 × IC339953 (52.216) had recorded significant positive sca effects while one cross IC339953 × IC355856 (48.987) exhibited significant negative sca effects for this trait.

The estimates of combining ability effects for harvest index revealed that one parent IC 355856 (2.768) expressed positive significant gca effects and the parent IC335858 (-2.378) exhibited significant negative gca effects for this trait. For positive significant sca effects, one cross IC339953 × IC355856 (9.757) had recorded significant positive sca effects while out of five crosses one cross IC338586 × IC355856 (8.059) exhibited significant negative sca effects for this traits.

The estimates of combining ability effects for test weight revealed that out of two, one parent IC335858 (1.478) expressed positive significant gca effects whereas out of three the parent IC342777 (-0.920) exhibited significant negative gca effects for this trait. For positive significant sca effects, Out of ten crosses, one cross IC335858 × IC338586 (2.544) had recorded significant positive sca effects whereas out of two crosses the cross IC338586 × IC355856 (-2.159) exhibited significant negative sca effects for this traits. Similar results were also discussed by Singh *et al*. (2019a).

The estimates of combining ability effects for seed yield revealed that one parent IC338586 (1.727) expressed positive significant gca effects whereas one parent IC355856 (-3.650) exhibited significant negative gca effects for this trait. reported significant GCA and non-significant SCA effect for seed yield Ram *et al*. 2018 and Inayat *et al*. 2019.

For positive significant sca effects, Out of ten crosses, one cross IC342777 × IC339953 (8.485) had recorded significant positive sca effects while out of two crosses one cross IC339953 × IC355856 (-6.644) exhibited significant negative sca effects for this traits.

Conclusion

On the basis of *per se* performance cross combination IC342777 × IC339953 found to be most promising for seed yield/plant. GCA effects revealed that IC-335858 followed by IC355856 having significant and positive GCA effects was found to be the best combiner for most of the yield traits and on the basis of SCA, IC-342777 × IC-339953 and IC342777 × IC355856 was recorded best specific combination for most of the yield contributing traits. It may be concluded that IC355856 is a good general combiner and IC342777 × IC355856 is a best specific combination for higher yield.

References

Ceyhan E, Avci MA, Karadas S. 2008. Line x tester analysis in pea (Pisum sativum L.): Identification of superior parents for seed yield and its components. *Afr J Biotechnol* 7:2810-2817

Channa SA. Hongyun Tian, Maarouf I. Mohammed, Ruijie Zhang, Shah Faisal, Yuan Guo, Miroslav Klima. Michael Stamm and Shengwu Hu. 2018. Heterosis and combining ability analysis in Chinese semiwinter exotic accessions of rapeseed (*Brassica napus* L.). *Euphytica* 214:134. https://doi.org/10.1007/s10681-018-2216-1

Gideon J. Synrem, N. R. Rangare, Anil K. Choudhari, Sujeet Kumar and Ibadaiahun Myrthong. 2015. Combining ability analysis for seed yield and component traits in Indian mustard [*Brassica juncea* (L.) Czern & Coss.]. *Electronic Journal of Plant Breeding* 6(2): 445-453

Griffing, B., 1956. Concept of general and specific combining ability in relation to diallel crossing systems. *Aust. J. Biol. Sci*. 9: 463-493.

Inayat S, Muhammad Zakirullah, Lubna Naz, Amna Shafi, Safia Akbar, Muhammad Ali and Shitab Khan. 2019 Combining ability analysis of yield and yield components in second filial (F2) generation of mustard (*Brassica juncea*), *Pure and Applied Biology* 8(2):1469-1477. http://dx.doi.org/10.19045/bspab.2019.80086

Kaur S, Kumar R, Kaur R, Singh I, Singh H and Kumar V. 2019. Heterosis and combining ability analysis in Indian mustard (*B. juncea* L.). *J Oilseed Brassica* 10 (1): 38-46

Kaur, G, Kaur, M and Kumar, R. 2020. Line × Tester analysis for quantitative traits in Indian mustard (*Brassica juncea* L.). *Journal of Oilseed Brassica*. 11 (1): 77-87

Kumar R, Kaur S, Bala K, Kaur S and Sharma L. 2019. Assessment of genetic variability, correlation and path analysis for yield traits in F_1 hybrids of Indian mustard [*Brassica Juncea* (L.) Czern & Coss.]. *Agriways* 7(1): 1-7.

Ram B, Priyamedha, Meena HS, Kumar A, Singh BK, Rani R, Kumar A, Singh KH and Rai BK. 2018. Studies on combining ability and gene action for heat stress tolerance traits in Indian mustard (*Brassica juncea* L.). *Journal of Oilseed Brassica*, 9 (2): 139-145

Saleem N, Jan SA, Atif MJ, Khurshid H, Khan SA, Abdullah M, Jahanzaib M, Ahmed H, Ullah SF, Iqbal A, Naqi S, Ilyas M, Ali N, Rabbani MA. 2017. Multivariate based variability within diverse Indian mustard (*B. juncea* L.) genotypes. *Open J Genet* 7: 69-83.

Singh H, Kumar R, Kaur S, Singh I and Kaur R. 2019a. Genetic analysis of Indian mustard for yield by calculating heterosis and combining ability. *J Agri Sci* 10: 1-12.

Singh I, Kumar R, Kaur S, Singh H and Kaur R. 2019b. Combining ability studies using diallel mating design in Indian mustard [*B. juncea* (L.) Czern & Coss.]. *Indian J Agric Res* 53: 366-369.

Table.1: Estimates for GCA effect for various character in Indian mustard.

S.No.	Genotypes	Days to first flowering	Days to 50% flowering	No. of primary branches	No. of secondary branches	Plant height (cm)	No. of siliquae per plant	Siliqua length (cm)	No. of seeds /siliqua	Days to maturity	Biological yield / plant (g)	Harvest index (%)	Test weight (g)	Seed yield /plant (g)
1	IC335858	2.876**	1.190	-0.081	-3.238*	-1.516	-50.924**	0.233	-0.662 *	1.352	14.040 **	-2.378**	1.478**	1.327
2	IC338586	-2.124**	-3.000**	0.329	-0.124	-0.202	-15.257	0.145	-0.233	-2.981	5.737	-0.430	-0.833**	1.727*
3	IC342777	-3.648**	-0.810	-0.124	1.314	6.722*	-18.793	-0.184	-0.052	-5.314**	2.376	0.505	-0.920**	1.322
4	IC339953	0.971	0.619	-0.095	2.210	4.750	21.386	-0.044	0.562	1.495	-0.241	-0.464	-0.588*	-0.726
5	IC355856	1.924**	2.000**	-0.029	-0.162	-9.754**	63.588 **	-0.150	0.386	5.448**	-21.912**	2.768**	0.862**	-3.650**
	Gi--Gj at 95%	2.411**	2.718**	1.077**	6.672**	12.065**	52.776 **	0.668	1.240**	7.153**	13.263**	2.443**	1.055**	3.300**
	Gi--Gj at 99%	3.998**	4.507**	1.786**	11.064**	20.006**	87.516 **	11.108	2.056**	11.862**	21.994**	4.052**	1.750**	5.472**
	h2 narrow sense	0.481	0.367	-0.092	0.053	0.209	0.475	0.027	0.128	0.248	0.234	0.148	0.401	0.263
	h2 broad sense	0.913	0.818	0.398	0.616	0.783	0.827	0.376	0.681	0.800	0.944	0.935	0.910	0.852

*, ** significant at 5% and 1% level, respectively

Table 2: Estimates of SCA effects for various characters in Indian mustard.

S.No.	**Genotypes**	Days to first flowering	No. of primary branches	No. of secondary branches	Plant height (cm)	No. of siliquae per plant	Siliquae length (cm)	No. of seeds /siliqua	Days to maturity	Biological yield / plant (g)	Harvest index (%)	Test weight (g)	Seed yield /plant (g)
1	IC335858 × IC338586	2.825	-0.448	5.051	16.927*	39.964	10.352	2.051*	1.095	-7.427	2.753	2.544**	1.461
2	IC335858 × IC342777	5.349**	1.171	4.679	5.137	68.500	10.381	-0.063	-3.238	5.435	-1.566	2.121**	-0.634
3	IC335858 × IC339953	1.063	1.343	7.051	9.308	45.321	10.354	-1.511	1.619	-9.248	4.960**	1.133	4.513*
4	IC335858 × IC355856	5.111**	-0.590	-1.511	20.946*	-39.048	10.786	0.365	-4.333	5.699	-0.832	0.043	3.137
5	IC338586 × IC342777	0.016	-0.238	-2.235	9.956	4.333	10.103	1.475	14.762**	-11.733	-2.813	-0.611	-5.134*
6	IC338586 × IC339953	0.397	-0.600	-9.130*	3.927	13.155	-10.237	-1.640*	-2.714	19.354*	-3.951*	-0.510	0.413
7	IC338586 × IC355856	2.444	1.333	9.241*	-7.235	-66.714	-10.965*	0.137	-12.667*	43.055**	-8.059**	-2.159**	1.337
8	IC342777 × IC339953	-1.413	0.186	8.765*	8.670	-27.310	-10.176	0.179	-4.381	52.216**	-3.413*	0.344	8.485**
9	IC342777 × IC355856	-2.366	0.452	0.803	8.841	-90.262*	10.030	-0.178	-5.333	31.0896	-4.998**	-1.672*	4.742*
10	IC339953 × IC355856	-3.984	0.757	-7.092	-7.187	67.810	-10.177	-1.159	-9.476*	-48.987**	9.757**	1.343	-6.644**
	Sij<>0 at 95%	3.208	1.433	8.878	16.052	70.218	10.889	1.649	9.518	17.647	3.251	1.404	4.390
	Sij<> 0 at 99%	4.608	2.059	12.754	23.060	100.877	1.277	2.369	13.673	25.352	4.670	2.017	6.307

*, ** significant at 5% and 1% level, respectively